

Effects of Vojta Therapy on Gait of Children with Spastic Diplegia

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Abstract. [Purpose] This study aimed to investigate the effects of Vojta therapy on spatiotemporal gait parameters in children with spastic diplegia. [Methods] The study population consisted of 3 children diagnosed with spastic diplegia. The subjects were treated with Vojta therapy for 8 weeks and followed up for 8 weeks after completion of the therapy. Vicon motion analysis was used to determine the subjects' spatiotemporal gait parameters. [Results] The following results were noted in the changes of each joint angle in the sagittal plane after Vojta therapy. Subject 1 remained in phase throughout the entire gait cycle and did not show any noticeable improvement, even demonstrating a negative range of motion when compared to the baseline. Subject 2 showed a normal anti-phase in heel strike, and the mid-stance, and swing phases. Subject 3 showed a normal anti-phase in heel strike and mid-stance, but the anti-phase during the swing phase was not significantly different from the baseline. For subjects 2 and 3, compared to the baseline, the range of motion of the hip and knee increased but the range of motion of the ankle decreased. [Conclusion] The findings of this study indicate that Vojta therapy can do a good role in improve the spatiotemporal gait parameters of children with spastic diplegia.

Key words: Vojta therapy, Spastic diplegia, Spatiotemporal gait parameter

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INTRODUCTION

Children with spastic diplegia suffer from spasticity in the lower extremities, muscle weakness, imbalances in muscle contraction, and joint deformity¹⁾, which can induce various abnormal gait patterns such as excessive energy consumption during gait²⁾.

Gait, 4-point kneeling, and reflex creeping are forward movements used in cross-coordination exercises. These are cyclical exercises that include several gait cycles³⁾. The use of reflex-creeping and reflex turning in Vojta therapy improves the gait function of children with spastic diplegia by improving the balanced muscle contractions in the body⁴⁾.

The reflex-creeping posture induces the central pattern generator (CPG) by activating response neurons that produce periodic rhythmic movement patterns⁵⁾. CPG ensures that reflex actions generated during the gait cycle occur with suitable timing⁶⁾. Rossignol et al. reported that sensory stimulation is produced by direct action of CPG, and that this aspect is related to the stimulation of weight bearing and the position of the hip joint⁷⁾. Dietz et al. reported that the weight-bearing receptors are important for the stance

phase and gait control, and that afferent input at the hip joint is important for the activation of the crural muscle during gait^{8, 9)}.

CPG has a positive influence during the gait cycle. Therefore, interventions that induce the action of CPG are mainly conducted as treadmill gait training. However, no study has examined the effect of Vojta therapy, which induces CPG action, on the gait of children with spastic diplegia. Hence, the present study focused on the effects of Vojta therapy on the gait of children with spastic diplegia.

SUBJECTS AND METHODS

The study subjects were 3 children with spastic diplegia. The general characteristics of the subjects are noted in Table 1. Subjects 1 and 2 were able to walk independently and practiced neurodevelopmental therapy for 5 days per week. Subject 3 was able to climb the stairs without using a handrail and received physical therapy at an outpatient rehabilitation hospital 2 days per week. All subjects and their guardians signed an informed consent form after receiving information about the purpose and method of the study. The inclusion criteria were as follows: children with cerebral palsy and a diagnosis of spastic diplegia, no diseases of the cardiovascular or pulmonary system, the ability to walk unaided without assistive devices for more than 10 m, and a gross motor function classification system of grade I or II. Patients were excluded if they had received Vojta therapy or botulinum toxin injections in the past 6 months, or orthopedic surgery in the previous year. The study was

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approved by the human research ethics committees of all the participating institutions.

The study design was a reversal (or ABBA) design in the single-subject experimental research design. Subjects were evaluated at the baseline at the ends of treatment 1, treatment 2, and a follow-up period. The study subjects performed Vojta therapy for 30 minutes per day, 3 days per week for 8 weeks.

A three-dimensional motion capture system (Vicon motion analysis system, Oxford, UK) with 6 infrared cameras was used to evaluate the kinematic variables of gait. A VICON optoelectronic system (Oxford Metrics, Oxford, UK) captured the drag-flicks with 6 cameras, with sampling at 120 Hz. The output signal captured motion-translated C3D of a standard motion analysis file. Subjects were evaluated using this anthropometric data. Fifty retroreflective markers (46 body markers and 4 stick markers; diameter, 14 mm) were attached to anatomical landmarks following a model adapted from VICON's kinematics model (Vicon Motion Systems, 2003).

A complete gait cycle is considered to be from heel strike to heel strike of the same leg, and includes all phases in between. To compare joint movements of the lower extremity during the stance phase before and after Vojta therapy, the gait cycle was divided by the action points of heel strike, mid-stance, and toe off in the stance phase. Subjects walked at a comfortable gait speed on a 10-m walkway. The subjects were evaluated 3 times, and the mean values were used.

The Vojta therapies used in this study were reflex creeping, Vojta's 3-point supporting, Vojta's Erste position, and varied reflex creeping (Fig. 1). Left and right stimulation were applied for 3 minutes for each of the therapies.

Repeated measures ANOVA was used to compare spatiotemporal gait parameters during the treatment period. SPSS 18.0 (Statistical Package for the Social Sciences) was used for statistical analysis, and values of $p < 0.05$ were considered significant.

Table 1. General characteristics of the subjects

	Gender	Age (years)	Height (cm)	Weight (kg)	GMFCS ^a level	Affected side
1	Female	6	97	13.6	II	Right
2	Male	8	128	27.0	II	Left
3	Female	12	147	41.0	I	Right

^aGMFCS, Gross Motor Function Classification System

RESULTS

The cadence of gait increased during treatment period 1, but decreased during treatment period 2 and the follow-up period. Moreover, walking speed and single limb support increased compared to the baseline. The following results were noted in the changes of each joint angle in the sagittal plane after Vojta therapy (Table 2). Subject 1 remained in phase throughout the total gait cycle and did not show much improvement, and a decreased range of motion compared to the baseline. Subject 2 showed a normal anti-phase during heel strike, and the mid-stance, and swing phases. Compared to the baseline, range of motion of the hip and knee joints increased, but range of motion of the ankle joint decreased. Subject 3 showed a normal anti-phase during heel strike and the mid-stance but an anti-phase during the swing phase that was not significantly different compared to the baseline. Compared to the baseline, range of motion of the hip and knee increased, but range of motion of the ankle decreased (Tables 3–5).

DISCUSSION

This study evaluated the effects of Vojta therapy on the spatiotemporal gait parameters of children with spastic

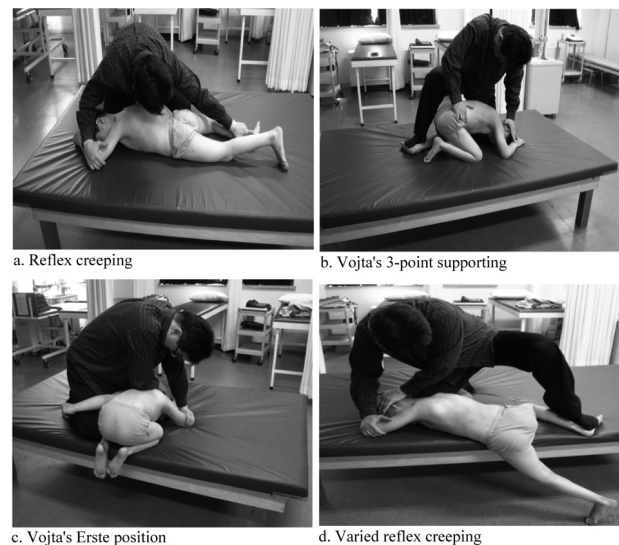


Fig. 1. The application of 4 Vojta therapies used to treat the three children with spastic diplegia

a. Reflex creeping, b. Vojta's 3-point supporting, c. Vojta's Erste position, d. Varied reflex creeping

Table 2. The comparison of subjects' spatiotemporal parameters of gait

	Baseline	Treatment 1	Treatment 2	Follow-up
Cadence (step/min)	105.63±12.72 ^a	107.46±9.66	99.31±36.92	91.59±33.44
Walking speed (m/sec)	0.68±0.25	0.75±0.43	0.72±0.54	0.61±0.42
Stride length (m)	0.80±0.37	0.81±0.46	0.77±0.48	0.72±0.42
Single limb support (%)	48.00±3.50	47.22±2.94	52.91±7.26	52.91±7.26

All variables are shown as the mean ± SD

diplegia. The cadence of gait increased during treatment period 1, but decreased during treatment period 2, and the follow-up period. Furthermore, walking speed and single limb support increased compared to the baseline. Lee et al. reported the following results of gait analysis using a three-dimensional motion capture system: mean age, 7.52 years; cadence, 136.91 steps/min; gait velocity, 1.31 m/sec; and stride length, 1.15 m¹⁰. Jung et al. reported a mean age, cadence, gait velocity, and stride length of 8.5 years, 105.6 steps/min, 1.04 m/sec, and 1.19 m, respectively¹¹. In the present study, the gait cadence of the subjects at the baseline at the end of treatment period 1 was similar to that of normal children. Moreover, the gait cadence, gait velocity, and stride length at the end of treatment period 2 and the follow-up period were different from those of normal children. Spatiotemporal gait parameters increased during treatment period 1, but decreased during treatment period 2, and the follow-up period.

Mann reported that a decreased stride length was an important characteristic of children with cerebral palsy¹². Heo compared kinematic analysis of gait motion of normal children and children with cerebral palsy, and reported that normal children had an increased stride length at a fast gait

speed, whereas the stride length of children with cerebral palsy did not increase at a fast gait speed¹³. As reported in other studies, this study noted a decreased stride length, at a fast gait speed.

Park et al. reported that single limb support time was long and double limb support time was short during fast walking and that this trend was reversed during slow walking¹⁴. Moreover, adults with spastic diplegia had short single limb support time and long double limb support time, because of gait speed. In the present study, the single limb support time slightly decreased during the treatment period 1, but increased during treatment 2 and the follow-up period, as compared to baseline, but these differences were not significant. These results that induced by improving balance function when step length and short time standing were longer through no gait training was same that single support time in results of this study increased¹⁵. The change in each joint angle in the sagittal plane after Vojta therapy increased during treatment period 1, decreased during treatment period 2, and increased during the follow-up, when compared to baseline; however, these changes were not significantly different among the 3 periods. Farmer et al. reported that, when compared to the gait of normal children, children

Table 3. Average hip angle in the sagittal plane at baseline and the end of each period (Unit: °)

Affected side	Baseline	Treatment 1	Treatment 2	Follow-up
HS**	36.59±10.30 ^a	38.40±14.54	33.07±22.01	40.49±11.66
MS***	16.05±17.10	18.58±12.87	13.83±21.40	20.77±14.09
TO****	0.41±13.10	5.10±9.08	-1.44±14.22	5.73±11.34
Max fl	26.41±31.41	29.81±30.90*	23.30±29.01	30.71±31.09
Min fl	-0.50±12.79	2.59±7.79	-2.97±12.81	3.50±10.00

All variables are shown as the mean ± SD. *, p<0.05; **HS, heel strike; ***MS, mid-stance; ****TO, toe off; Max fl, maximum flexion; Min fl, minimum flexion

Table 4. Average knee angle in the sagittal plane at baseline and the end of each period (Unit: °)

Affected side	Baseline	Treatment 1	Treatment 2	Follow-up
HS**	26.85±24.01 ^a	34.94±13.67	24.51±10.71	36.11±12.26
MS***	16.45±19.63	25.72±14.84	15.90±18.36	25.15±15.42
TO****	26.02±19.14	36.63±13.52	22.70±17.15	30.54±19.68
Max fl	43.98±42.47	51.17±39.01	39.05±30.43	51.85±34.36
Min fl	10.87±18.63	22.14±15.60	11.16±21.24	22.44±17.47

All variables are shown as the mean ± SD. *, p<0.05; **HS, heel strike; ***MS, mid-stance; ****TO, toe off; Max fl, maximum flexion; Min fl, minimum flexion

Table 5. Average ankle angle in the sagittal plane at baseline and the end of each period (Unit: °)

Affected side	Baseline	Treatment 1	Treatment 2	Follow-up
HS**	1.72±5.49 ^a	10.72±11.94	7.66±7.62	5.89±2.64
MS***	10.37±6.11	18.60±9.13*	14.64±8.52	17.98±3.63
TO****	11.07±14.04	21.64±10.56	17.99±17.32	20.84±9.78
Max fl	10.25±11.80	17.32±14.83	13.91±5.97	16.76±13.65*
Min fl	-18.43±14.51	-8.45±19.19	-10.01±23.03	-8.24±13.59

All variables are shown as the mean ± SD. *, p<0.05; **HS, heel strike; ***MS, mid-stance; ****TO, toe off; Max fl, maximum flexion; Min fl, minimum flexion

with cerebral palsy had an increase of approximately 11.00° in maximal hip flexion, 9.00° in minimal hip flexion, and 8.20° in minimal knee flexion, and a decrease of approximately 7.00° in maximal knee flexion¹⁶⁾.

In the present study, the change in each joint angle in the sagittal plane occurred as follows. Subject 1 remained in phase during the entire gait cycle and did not show much improvement, even showing a reduced range of motion when compared to the baseline. Subject 2 showed a normal anti-phase during heel strike, and the mid-stance, and swing phases. Compared to the baseline, range of motion of the hip and knee joints increased, but range of motion of the ankle joint decreased. Subject 3 showed a normal anti-phase during heel strike and mid-stance; however, an anti-phase was observed during the swing phase, but was not significantly different from the baseline. Compared to the baseline, range of motion of the hip and knee joints increased but range of motion of the ankle decreased. These results suggest that ideal joint angles can be obtained through rhythmical coordination of gait by using reflex creeping, 3-point weight bearing, and varied reflex creeping that stimulate the weight-bearing receptors. Furthermore, direct stimulation of the anterior superior iliac spine and the tendon of the gluteus medius muscle may increase the afferent input at the hip joint.

Children with spastic diplegia that have excessive flexion of the hip and knee joints and about 8.00° less range of motion than normal children because of the excessive flexion of the hip joint¹⁶⁾. Limited neck and trunk flexion of children with neuromuscular diseases such as cerebral palsy, results in rigidity of the spine. Stretching the neck and trunk improves spinal elongation¹⁷⁾. Increasing spinal elongation decreased excessive range of motion at the hip joint¹⁸⁾. In the present study, improvement in the range of motion of the hip and knee joints of subjects 2 and 3 may have been due to an increased range of motion because of decreased excessive flexion at the hip and knee joints through elongation of the spinal longitudinal axis in the Erste position, reflex creeping, and varied reflex creeping. Nevertheless, subject 1 appeared to have degeneration of phasic coordination with a decreased range of motion when compared to the baseline. When the subjects of this study were instructed to maintain a comfortable speed during walking, subject 1 appeared to have excessive postural sway at a fast gait speed; as time passed, this sway induced excessive instability and a slow gait speed. Walking was not assessed again for subject 1 because of decreasing postural sway and excessive instability. The results of this study indicate that Vojta therapy is an effective intervention for cerebral palsy patients with an abnormal gait pattern.

The limitations of this study were that the results are not generalizable to all children with spastic diplegia, because

of the small number of subjects and lack of a control group, and differences in the ages of the subjects and small differences in gait's patterns. Further research is required to determine the effects of Vojta therapy in a randomized controlled trial.

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REFERENCES

- 1) Crenna, Inverno, Frigo et al.: Pathophysiological profile of gait in children with cerebral palsy. *Movement disorders in children*, 1991, pp 186–198.
- 2) Gage RJ: *Gait analysis in cerebral palsy*. New York: Cambridge University Press, 1991.
- 3) Vojta V, Peters A: *Das vojta-prinzipmuskelspiele in reflexfortbewegung und motorischerontogenese*, 3rd ed. Heidelberg: Springer MedizinVerlag, 2007.
- 4) Park GH, An YP: The possible mechanism of Vojta therapy in the brain damaged. *Korean Assoc Med J*, 1989, 13: 1–10.
- 5) Grillner S, Wallén P: Central pattern generators for locomotion, with special reference to vertebrates. *Annu Rev Neurosci*, 1985, 8: 233–261. [[Medline](#)] [[CrossRef](#)]
- 6) Duysens J, Tax AA, Trippel M, et al.: Phase-dependent reversal of reflex induced movements during human gait. *Exp Brain Res*, 1992, 90: 404–414. [[Medline](#)] [[CrossRef](#)]
- 7) Rossignol S: Neural control of stereotypic limb movements. In: LB Rowell and JT Sheperd Editors, *Exercise: Regulation and integration of multiple systems*. Handbook of Physiology Sect. 12. American Physiological Society, Bethesda, 1996, pp 173–216.
- 8) Dietz V: Human neuronal control of automatic functional movements. Interaction between central programs and afferent input. *Physiol Rev*, 1992, 72: 33–69. [[Medline](#)]
- 9) Dietz V, Müller R, Colombo G: Locomotor activity in spinal man: significance of afferent input from joint and load receptors. *Brain*, 2002, 125: 2626–2634. [[Medline](#)] [[CrossRef](#)]
- 10) Lee JH, Bae SS, Kim JS: Three-dimensional video analysis of the gait patterns in normal children and hemiplegic children with cerebral palsy. *J Korean Soc Phys Ther*, 1997, 9: 127–145.
- 11) Jung JY, Park BS, Choi IH, et al.: Three dimensional gait analysis in normal Korean –a preliminary report. *J Korean Orthop Assoc*, 2005, 40: 83–88.
- 12) Mann R: Biomechanics in cerebral palsy. *Foot Ankle*, 1983, 4: 114–119. [[Medline](#)] [[CrossRef](#)]
- 13) Heo JS: Effects of consistently kinematic feedback on stability of motion coordination in cerebral palsy. *Korea Sport Res*, 2000, 11: 187–200.
- 14) Park ES, Park CI, Jo JR, et al.: Comparison of energy consumption on cerebral palsy during gait. *J Korean Acad Rehabil Med*, 2004, 28: 537–541.
- 15) Vojta V: *Die zerebralenbewegungsstörungenimsauglingsalter*. Ferdinand EnkeVerlag Stuttgart, 1984.
- 16) Farmer SE, Pearce G, Stewart C: Developing a technique to measure intra-limb coordination in gait: applicable to children with cerebral palsy. *Gait Posture*, 2008, 28: 217–221. [[Medline](#)] [[CrossRef](#)]
- 17) Cuccurullo S: *Physical Medicine and Rehabilitation Board Review*. New York: Demos Medical Publishing, 2004.
- 18) Feland JB, Myrer JW, Schulthies SS, et al.: The effect of duration of stretching of the hamstring muscle group for increasing range of motion in people aged 65 years or older. *Phys Ther*, 2001, 81: 1110–1117. [[Medline](#)]